International Journal of Odonatology, 2017
Vol. 20, Nos. 3–4, 165–172, https://doi.org/10.1080/13887890.2017.1362363

The female of *Oreiallagma oreas* (Odonata: Coenagrionidae), with notes on the species natural history

Cornelio A. Bota-Sierra [a,b] and Juliana Sandoval-H [c*]

[a]*Red de Biodiversidad y Sistemática, Instituto de Ecología, A.C. Xalapa, Veracruz, Mexico;* [b]*Grupo de Entomología Universidad de Antioquia (GEUA), Universidad de Antioquia, Medellin, Colombia;* [c]*Departamento de Ciencias Biológicas, Facultad de Ciencias Naturales, Universidad ICESI, Calle 18 No. 122–135, Cali, Colombia*

(*Received 21 April 2017; final version received 28 July 2017*)

Oreiallagma oreas (Ris, 1918) is a recently rediscovered Colombian Andean endemic species, for which the information available is very scarce. It was originally described from a single male. Since 2008, *O. oreas* has been recorded in new localities but its life history remained unknown. Here we describe and diagnose the species female for the first time and show evidence of female dichromatism in the genus. Also, we present photographs and illustrations of males and females, a distribution map, and information on this species biology, reporting that it breeds on bromeliads as other species in the genus.

Keywords: Andes; bromeliad breeding; Colombian endemic; color polymorphism; damselfly; dragonfly; Zygoptera

Introduction

Within Coenagrionidae, the genus *Oreiallagma* is part of the core clade, which contains over 650 species (Dijkstra, Kalkman, Dow, Stokvis, & Van Tol, 2014). This genus was described by von Ellenrieder and Garrison (2008), who grouped and diagnosed five rare species that were previously included within the genera *Acanthagrion* Selys 1876, *Cyanallagma* Kennedy, 1920, and *Telagrion* Selys, 1876: *Oreiallagma acutum* (Ris, 1918), *Oreillagma quadricolor* (Ris, 1918), *Oreiallagma prothoracicum* (Kimmins, 1945), *Oreiallagma oreas* (Ris, 1918), and *Oreiallagma thelkterion* (De Marmels, 1997), endemics from Bolivia, Peru, Ecuador, Colombia, and Venezuela respectively, where they inhabit the Andean mountain range from 800 to 2300 m. The information available on the biology of these five species is scarce, and only the females of *O. thelkterion* and *O. quadricolor* have been described. The larvae of *O. quadricolor*, only one known so far, breeds in water held in bromeliads (von Ellenrieder & Garrison, 2008).

Oreiallagma oreas was described by Ris (1918) from a single male specimen collected by Fassl in 1909 at the Monte Socorro gold mines, located at the Valle del Cauca department, Cordillera Occidental at 2300 m (Figure 1). After its discovery, it was not found again until a century later in Antioquia, approximately 300 km north in the Central Cordillera, sharing its habitat

*Corresponding author. Email: julisando@gmail.com

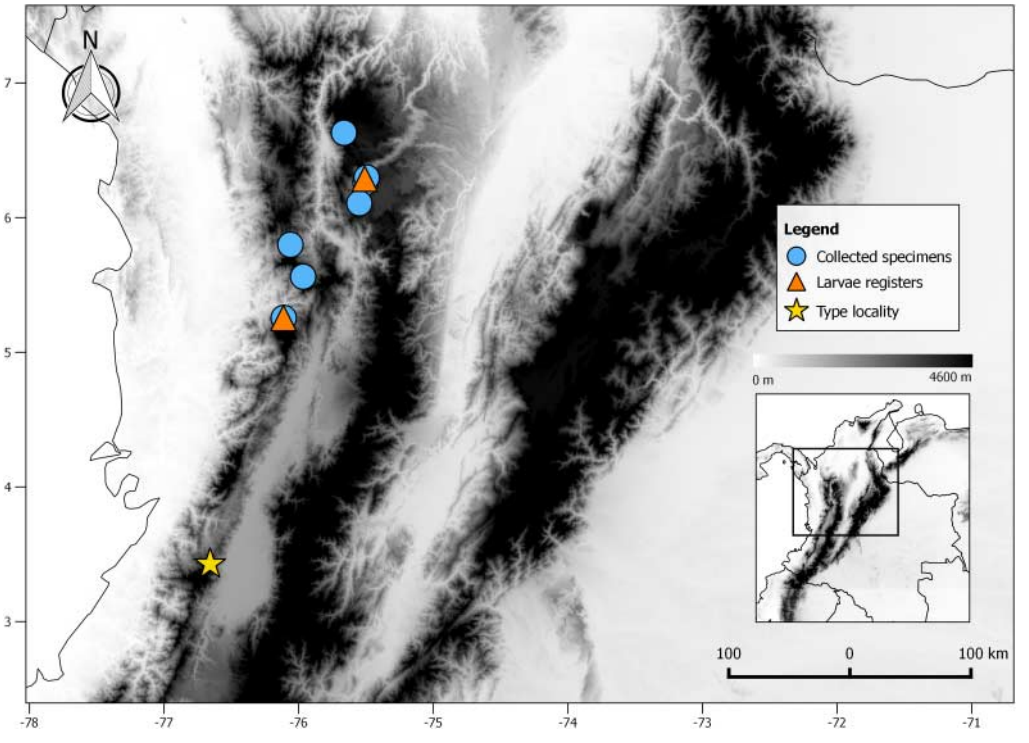

Figure 1. Distribution map for *Oreiallagma oreas*.

with *Mesamphiarion risi* and *Mesamphiagrion rosseri* (Bota-Sierra & Wolff, 2013). Other localities at the Western and Central cordilleras in Antioquia, from 2000 to 3300 m, were reported in the assessment made by the IUCN, where the species was classified as least concern due to its presence in protected areas (Bota-Sierra, Palacino, & Rache, 2016). Here, we describe for the first time the female of *O. oreas* and complete the diagnosis of the males with photographs of the genital ligula and live specimens in their habitat. We also contribute with natural history notes and records on new localities, consequently expanding the known geographical and altitudinal distribution for the species.

Methods

Specimen collection

The specimens were collected between 2008 and 2016 in different localities on Andean forests of the Central and Western Cordilleras in Antioquia and Risaralda, Colombia. Each locality was georeferenced; and notes on behavior, habitat, as well as photographs of the site and the specimens were taken. Specimens were deposited in the Colección Entomológica Universidad de Antioquia, Medellín, Colombia (CEUA).

Laboratory phase

Male specimens were identified using the key of von Ellenrieder and Garrison (2008), females were identified by association. Museum specimens were photographed using a digital camera

Canon sx50 HS (Tokyo, Japan) and an Olympus SZX16 (Tokyo, Japan) stereoscope. Illustrations were handmade with the aid of an AM Scope stereoscope (Irving, Canada) and its grid. Maps were composed in QGIS v.2.8.3 (QGIS Development Team, 2017) using WorldClim elevation data (Hijmans, Cameron, Parra, Jones, & Jarvis, 2005). Measurements were taken using graph paper and lens ruler. Total length include caudal appendages and abdominal length exclude them. Abbreviations are as follows: ♀ females, ♂ males FW: forewing; HW: hind wing; pt: pterostigma; Ax: antenodal cross veins; Px: postnodal cross veins; S1–10: abdominal segments one to 10. Terminology follows Garrison, von Ellenrieder, and Louton (2010). Morphs that resemble the male's coloration are referred as androchrome and typical cryptic female morphs as gynochrome (Andrés, Sánchez-Guillen, & Cordero Rivera, 2002).

Results

Description of female

Specimens examined

Specimens examined: 15 specimens: 8 ♀ and 7 ♂. Colombia: ANTIOQUIA department: 1 ♀ and 1 ♂, Municipality Andes, Township Santa Rita, El Desconsuelo, 5.56188°N 75.9664°W, 2900 m, 5 December 2009, Leg: N. Uribe, A. Bustamante, and C. Bota. 1 ♂, Municipality Belmira, Trail from Belmira towards El Morro, close to La Truchera. 6.63047°N 75.66310°W, 2900 m, 10 February 2017, Leg: A. L. Montoya. 1 ♂, Municipality Ciudad Bolivar, Township La Mina, 5.79873°N 76.06116°W, 1800 m, 28 May 2011, Leg: C. Bota, C. Flórez, and A. Bustamante. 1 ♂ and 1 ♀, Municipality Envigado, Township San Sebastián de la Castellana, 6. 10725°N 75.54917°W, 2890 m, 27 July 2014, Leg: C. Bota. Municipality Medellín, Arví Reserve: 1 ♀, Township Mazo, Alto Juan Gomez, 6.26191°N 75.50282°W, 2440 m, 23 June 2008, Leg: C. Bota. 1 ♂, same data but: Township Piedras Blancas 06.29786°N, 075.49454°W, 2480 m, 15 September 2012, Leg: J. D. Marin. RISARALDA department: Municipality Pueblo Rico, Township Monte Bello, Tatamá National Park: 2 ♀ and 1 ♂, Sector Los Chorros, 5.25496°N 76.11093°W, 2300 m, 15 May 2015, Leg: C. Bota. 1 ♀ and 2 ♂, same data but: 15 June 2015, Leg: C. Bota. 1 ♀, same data but, Trail towards Rio Bravo, 5.23026°N 76.09932°W 1570 m, 26 July 2016, Leg: J. Sandoval and C. Bota. 2 ♀, same data but, Road towards La Base, 3.4272°N 76.11279°W, 2400 m, 28 July 2016, Leg: J. Sandoval and C. Bota. All in CEUA.

Females were found to be dichromatic, with gynochrome ($n = 4$) and androchrome ($n = 4$) morphs.

Gynochrome females (Figure 2c)

Body covered by golden pubescence, longer on face and pterothorax.

Head. Dark brown. Labrum, ventral part of genae, base of mandibles, and gap between lateral ocelli bluish-green. When alive, dorsal half of eyes black and ventral half greenish-blue. Elongated postocular spots, bluish-green, not sharply defined. Frons rounded. Antennae dark brown. Rear of head cream. Most posterior point of head at eyes.

Prothorax. Pronotum black with blue longitudinal stripe in anterior lobe and greenish-blue propleura. Medial projection of posterior lobe projected dorsally and convex (Figure 2a, b).

Pterothorax. Bluish green with wide black middorsal stripe; dark brown wide antehumeral stripe, interpleural sutures, and metapleural sutures, venter cream. Coxa and femur cream with

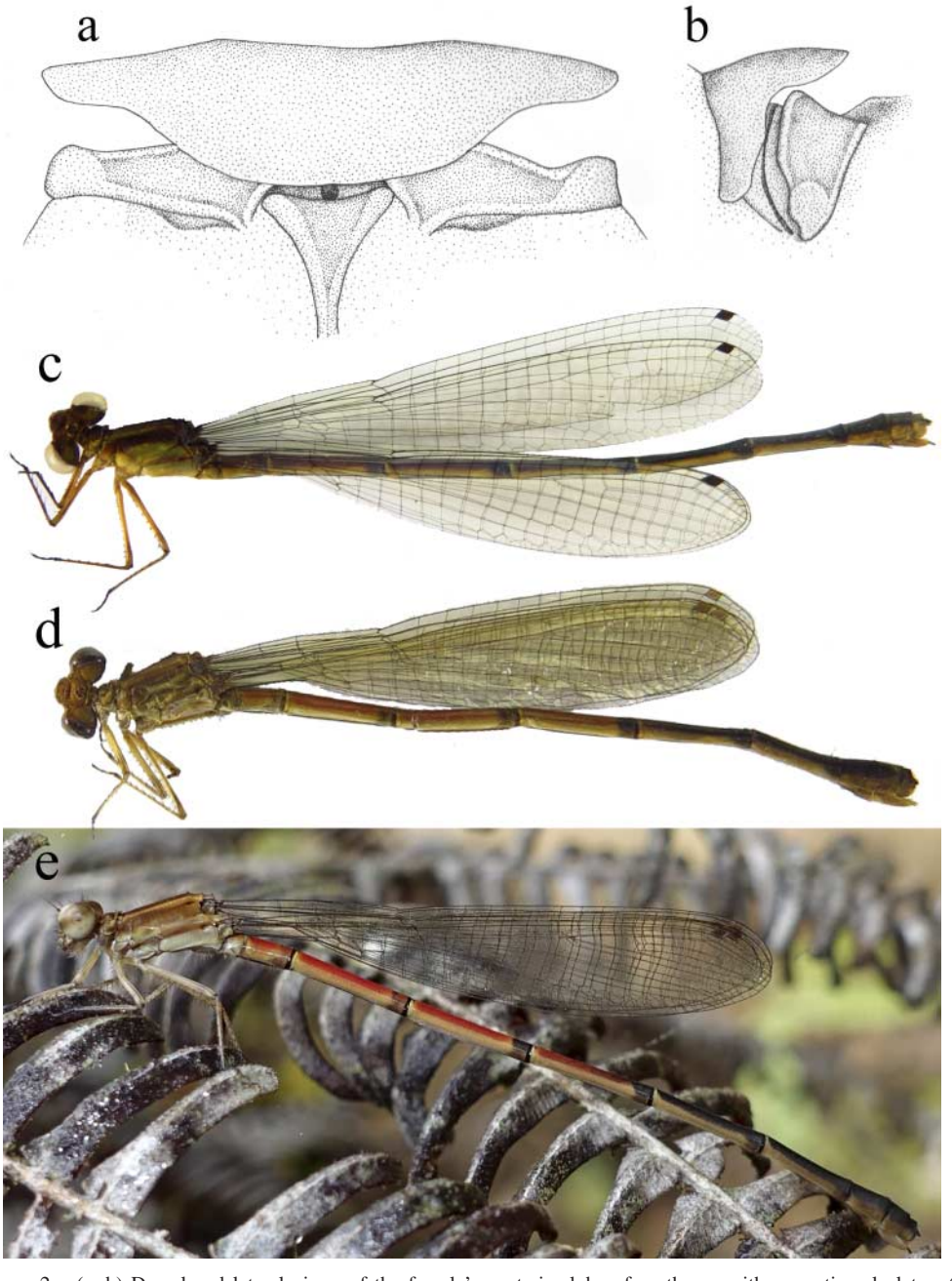

Figure 2. (a, b) Dorsal and lateral views of the female's posterior lobe of prothorax with mesostigmal plates; (c) gynochrome female; (d) androchrome female; (e) immature female.

distal apex black. Tibia brown, tarsomeres, claws, and armature dark brown. Nine external spurs on metafemurs, as long as the space between them or shorter, gradually increasing in size towards the apex. Nine external spurs on metatibia, as long as space between them or shorter, gradually decreasing in size towards the apex. Tarsal claw with well-developed supplementary tooth.

Abdomen. Dorsally black and ventrally cream except S1 greenish-blue on pleura, S1–5 reddish-brown on dorsum (due to the coloration change from red in tenerals to brown in mature individuals), apical greenish-blue rings on S1–6, S9 with middorsal rhomboidal blue spot, and S10 with apical middorsal hemispheric blue spot, paraproct and ovipositor cream. Ventral vulvar spine on S8. Cercus sub-conical, slightly shorter than S10 length, stylus surpassing tip of cerci. Wings hyaline. Pt brown, length ratio between distal and proximal sides about 1:1. CuP reaching CuP + AA slightly distal to confluence of CuP + AA with hind margin of wing. Px 15 in left and 16 in right in FW and 16 in left and 13 in right HW. RP2 branching between Px 7 and 8 in FW, between Px 6 and 7 in HW (Figure 2c).

Measurements. Total length 42 mm. Abdomen length 33 mm. FW length 26 mm. HW length 26 mm.

Androchrome females (Figure 2d)

Head. Golden brown with black margins on clypeus. Depression between antefrons, vertex, and antennae dark brown, extending to draw a line that splits antefrons in two parts. Postocular lobe with a bluish tinge. Antennomeres black.

Prothorax. Golden brown.

Pterothorax. Light brown with darker middorsal stripe, humeral and metapleural sutures.

Abdomen. Dorsally black and ventrally cream except: S1 reddish brown, S2–5 red on dorsum with distal fifth black, S9 distal half blue, paraproct and ovipositor cream. Wings smoked.

Other variation

Young individuals have the same coloration pattern as androchrome females (Figure 2e). Wing color varies from hyaline to infumated in brown. Px 13–15 in left and 12–15 in right FW; Px 11–13 in left and 11–16 in right HW. RP2 branching from five to eight in FW and from four to seven in HW.

Measurements. Total length 37–43 mm. Abdomen length 29–35 mm. FW length 25–26 mm. HW length 23–26 mm.

Key to known Oreillagma females

Based on the key of von Ellenrieder and Garrison (2008).

1 Posterior margin of medial lobe of posterior prothoracic lobe convex 2
1′ Posterior margin of medial lobe of posterior prothoracic lobe medially concave; Merida Mountain Range, Venezuela . . . . . *O. thelkterion*
2 Mesostigmal plates with proximal border straight; Southern Peruvian Andes . . . . . *O. quadricolor*
2′ Mesostigmal plate with proximal border concave (Figure 2a, b); Occidental and Central Mountain Ranges, Colombia (Figure 1) . . . . . *O. oreas*

Notes on males

The description of the holotype from Ris (1918) is very complete and accurate. von Ellenrieder and Garrison (2008) illustrated the holotype, allowing accurate identification of the species by comparison with caudal appendages, but its genital ligula was somehow distorted. Here we present a picture of the genital ligula of one of the recently collected males (Figure 3a); it bears two lateroapical processes with sharp tips directed distally, which are not shown on the holotype's ligula illustration. Also, we present for the first time pictures of mature and immature males showing the coloration pattern described by Ris (Figure 3c, e).

Distribution

There were previous reports of this species in the Central and Western Cordilleras at the departments of Valle del Cauca and Antioquia; we also found it in two more localities that are protected by the government for their ecological importance: Páramo de Belmira in Antioquia and the Tatamá National Park at the Risaralda department in elevations from 1570 to 2500 m (Figure 1), at the western slope of the Cordillera Occidental.

Biology

Larval exuviae were found attached (Figure 3d) to *Guzmania* spp. bromeliads (Figure 3b) at Parque Arví and at the Tatama National Park (Figure 1), where a teneral that had just emerged was found next to the plant. Most of the specimens where collected during the dry seasons spanning from June to August and December to February, during nine months of continuous sampling at Tatamá National Park (February–July 2015 and June–August 2016). We observed an abrupt increase in the abundance of adults during the dry season; concurrently, the bromeliads they use to breed were almost dry.

Discussion

This is the first record of the presence of female polymorphism on the genus *Oreiallagma*, with evidence of mature androchrome "red" females and gynochrome "greenish blue females", the latter changing their body coloration from red when immature, to brown and blue when mature. Female color polymorphism is a widespread characteristic in Odonata (Van Gossum, Sherratt, & Cordero-Rivera, 2008), with the majority of the known species, 74 within 12 genera, showing this trait in the Coenagrionidae family (Bota-Sierra & Wolff, 2013; Fincke, Jödicke, Paulson, & Schultz, 2005). Most of them (67 species in eight genera) are part of the core Coenagrionidae clade, so it is not surprising that this characteristic is present in the *Oreiallagma* genus. Color polymorphism could act as a strategy to avoid male harassment (Andrés et al., 2002; Gosden & Svensson, 2009; Van Gossum et al., 2008), as visual cues are the primary source in damselfly mate recognition (Winfrey & Fincke, 2017).

The seasonality, marked by periods of drought and rains in the Colombian Andes, affects the content of water in bromeliad species, also affecting their phenology (Jaramillo & Cavelier, 1998). Bromeliads are hosts to many species of macroscopic fauna; the volume of water retained is significantly correlated with the richness inside the plant (Armbruster, Hutchinson, & Cotgreave, 2002), which is also positively correlated with the amount of nutrients that it can provide to the inhabitant macrofauna (Richardson, 1999). The changes in the availability of resources could be triggering the marked, rainfall related seasonality in the presence of *O. oreas* adults. Further

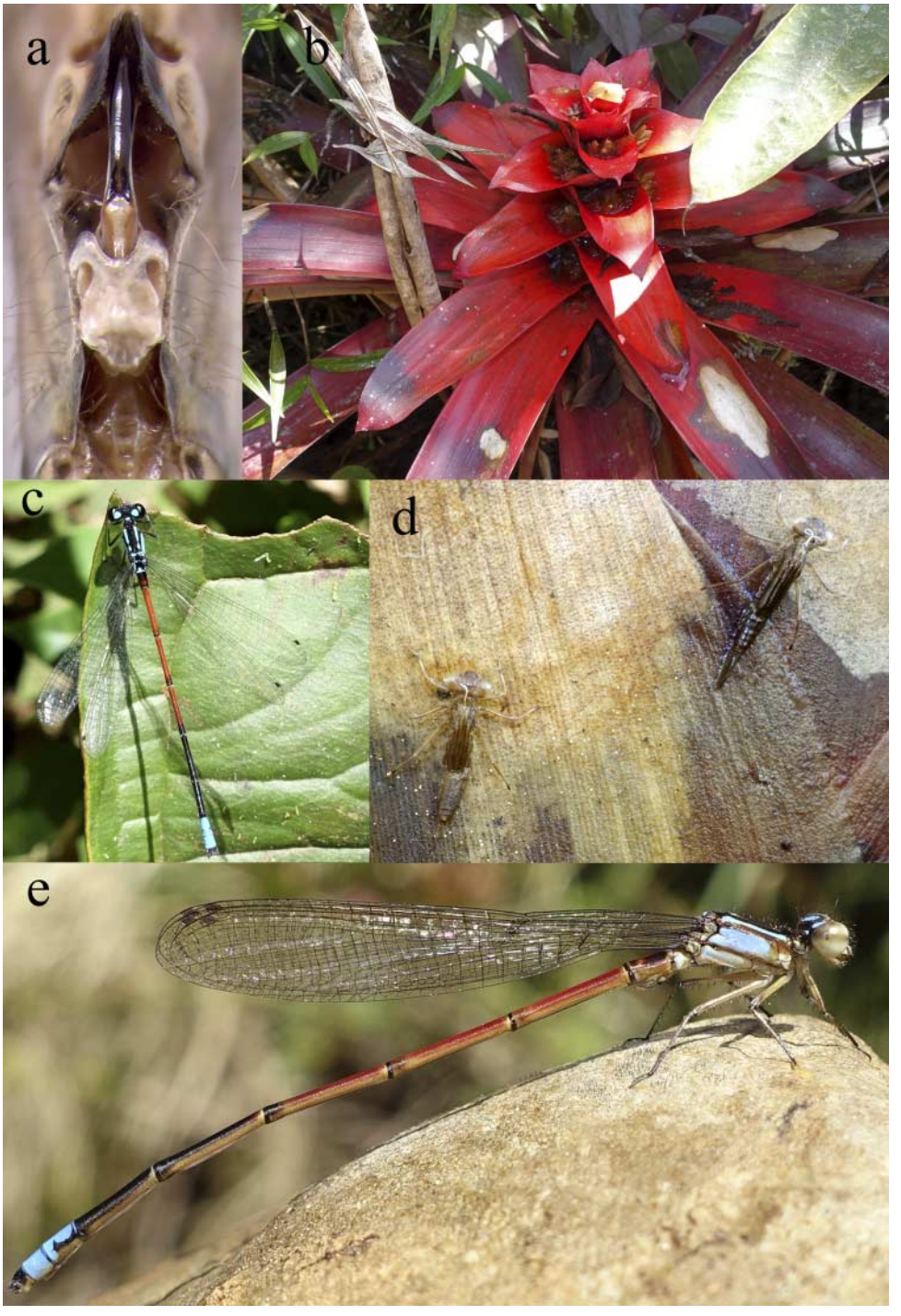

Figure 3. (a) Ectal view of male genital ligula; (b) *Guzmania* sp. bromeliad where exuviae were found; (c) mature male; (d) exuviae found attached to *Guzmania* sp.; (e) immature male.

studies should be performed in order to better understand these interactions, especially with the anomalous fluctuations of the rainy seasons we are experimenting due to climatic change, which could result in a critical threat for the survival of this bromeliad related community.

Acknowledgements

We thank A. F. Montoya, C. Flórez, and N. von Ellenrieder for their valuable corrections and suggestions on the manuscript; F. García and J. Torres for the assistance with laboratory photographs. We are grateful to N. Uribe for her beautiful handmade illustrations. We also thank D. Ayala, A. Orejuela, J. D. Marin, N. Uribe, A. Bustamante, C. Flórez, A. L. Montoya, and F. García for collecting some of the examined specimens and their invaluable help in the field. We thank G. Londoño and Montezuma Rainforest for providing supplies and logistic assistance at Tatamá Station. We thank Tatamá National Park research equipment and rangers for their help during all the research performed there.

Funding

This work was partially supported by the Rufford Foundation [grant number 19846-1].

ORCID

Cornelio A. Bota-Sierra http://orcid.org/0000-0002-6555-7913
Juliana Sandoval-H. http://orcid.org/0000-0002-9369-2717

References

Andrés, J. A., Sánchez-Guillen, R. A., & Cordero Rivera, A. (2002). Evolution of female colour polymorphism in damselflies: testing the hypotheses. *Animal Behavior, 63*, 677–685. doi:10.1006/anbe.2001.1948

Armbruster, P., Hutchinson, R. A., & Cotgreave, P. (2002). Factors influencing community structure in a South American tank bromeliad fauna. *Oikos, 96*, 225–234. doi:10.1034/j.1600-0706.2002.960204.x

Bota-Sierra, C., Palacino, F., & Rache, L. (2016). *Oreiallagma oreas*. The IUCN Red List of Threatened Species 2016: e.T49254700A49255393. http://doi.org/10.2305/IUCN.UK.2016-1.RLTS.T49254700A49255393.en. Downloaded on 24 March 2017.

Bota-Sierra, C., & Wolff, M. I. (2013). Taxonomic revision of *Mesamphiagrion* Kennedy, 1920 from Colombia (Odonata: Coenagrionidae), with the description of four new species. *Zootaxa*, *3718*, 401–440. doi:10.11646/zootaxa.3718.5.1

Dijkstra, K. D. B., Kalkman, V. J., Dow, R. A., Stokvis, F. R. & Van Tol, J. (2014). Redefining the damselly families: a comprehensive molecular phylogeny of Zygoptera (Odonata). *Systematic Entomology, 39*, 68–96. doi:10.1111/syen.12035

Fincke, O. M., Jödicke, R., Paulson, D., & Schultz, T. D. (2005). The evolution and frequency of female color morphs in Holartic Odonata: why are male-like females typically the minority? *International Journal of Odonatology*, *8*, 183–212. doi:10.1080/13887890.2005.9748252

Garrison, R. W., von Ellenrieder, N., & Louton, J. A. (2010). *Damselfly genera of the New World: An illustrated and annotated key to the Zygoptera.* The Johns Hopkins University Press: Baltimore.

Gosden T. P., & Svensson, E. I. (2009). Density-Dependent Male Mating Harassment, Female Resistance, and Male Mimicry. *The American Naturalist*, *137*, 709–721.

Hijmans, R. J., Cameron, S. E., Parra J. L., Jones P. G., & Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, *25*, 1965–1978. doi:10.1002/joc.1276

Jaramillo M. A., & Cavelier, J. (1998). Fenología de dos especies de Tillandsia (Bromeliaceae) en un bosque montano alto de la Cordillera Oriental Colombiana. *Selbyana*, *19*, 44–51.

QGIS Development Team. (2017). QGIS Geographic Information System. Open Source Geospatial Foundation Project. http://www.qgis.org/

Richardson, B. A. (1999). The bromeliad microcosm and the assessment of faunal diversity in a Neotropical forest. *Biotropica, 31*, 321–336. doi:10.1111/j.1744-7429.1999.tb00144.x

Ris, F. (1918). Libellen (Odonata) aus der Region der amerikanischen Kordilleren von Costarica bis Catamarca. *Archiv für Naturgeschichte, A(9)*, 1–197. Retrieved from http://biostor.org/reference/66155

Van Gossum, H., Sherratt, N. T., & Cordero-Rivera, A. (2008). The evolution of sex-limited colour polymorphism. In A. Córdoba-Aguilar (Ed.), *Dragonflies & damselflies: Model organisms for ecological and evolutionary research* (pp. 219–229). Oxford: Oxford Biology.

von Ellenrieder, N., & Garrison, R. W. (2008). *Oreiallagma* gen. nov. with a redefinition of Cyanallagma Kennedy 1920 and Mesamphiagrion Kennedy 1920, and the description of M. dunklei sp. nov. and M. ecuatoriale sp. nov. from Ecuador (Odonata: Coenagrionidae). *Zootaxa*, *1805*, 1–51.

Winfrey, C., & Fincke, O. M. (2017). Role of visual and non-visual cues in damselfly mate recognition. *International Journal of Odonatology*, *20*, 43–52. doi:10.1080/13887890.2017.1297259